Adrian, Missouri
Water Supply Study
City Lake

Adrian Lake is located just East of the city in Northern Bates County, Missouri.

Adrian has two lakes, the main lake supplies their water needs. A smaller upstream lake is used to catch sediment to keep the lower lake from losing capacity.

Rainfall at Butler was used for this analysis. Average annual rainfall for 1970 through 2000 was 42.05 inches. Annual Rainfall at Butler for 1953 through 1957 is 28.8, 35.7, 28.4, 21.3, and 37.5 inches.

Adrian used approximately 0.373 million gallon per day during year 2000.
The optimized use without pumping from South Grand River is estimated to be only 49,500 gallon per day.

Because the city's lake has a small capacity, it will not supply Adrian's total needs. As a result they pump from South Grand River into their lake from a location East of highway 71. The demand of 0.373 MGD can be met by pumping from South Grand River 2/3 of the time that flow in the river exceeds 3 cubic feet per second.

Adrian's Lake analysis consisted of using the NRCS's computer program "RESOP". This program analyzes remaining stored water at the end of each month by summing gains and losses.

Following is the data and procedures for input to the "RESOP" program.

STO-AREA Elevation-Storage and Elevation-Area data were determined from June 6, 2003 survey made by USGS.

Adrian Lake

Elevation (feet)	Area (acres)	Volume (acre-ft)	
Lower Lake			
832	0.4	0.1	
834	2.9	3.4	
836	7.1	12.7	
838	13.9	33.5	
840	21.5	69.1	
842	29.7	120.0	
844	42.0	190.0	
846	47.7	280.0	Water Surface 6/6/2003
846.2	49.8	290.0	Spillway Elevation
Upper Lake			
844	0.1	0.01	
846	0.9	1.0	
848	2.9	4.0	
850	5.8	13.0	
850.7	7.4	17.0	Water Surface 6/6/2003
852	12.7	31.0	
852.3	13.8	35.0	Spillway Elevation

LIMITS

Upper Lake
Full Pool storage 35 Ac.Ft.
Minimum Pool storage 0 Ac.Ft.

Lower Lake
Full Pool storage 290 Ac.Ft.
Minimum Pool storage 40 Ac.Ft.

Starting storage was considered at full pool elevation.

The upper lake drainage is 0.55 square miles and the lower lake has a total drainage including the drainage area of the upper lake of 0.81 Square Miles (517 Acres).

GENERAL

The adjustment factor of 0.76 to convert from Pan evaporation to Lake evaporation as applied prior to entering the data for the control word EVAP. As a result a factor of 100 is applied.

The record period of drought is in the 1950's. The analysis period was January 1951 through December 1959

SEEPAGE

The reservoir seepage for the upper lake is near zero. Most of any seepage would appear in the lower lake. A value of 0.2 inches per month when full was used and 0 seepage as the water level approached the lower limits of the pool.

Seepage from the larger, lower lake was estimated at 2 inches per month when full to 0 at the lower limits of the pool.

The material in the dam is compacted earth of clayey soils. As a result seepage rates are low.

RAINFALL

Rainfall data came from the Butler, Mo. rain gage and supplemented where needed with the Appleton City rainfall data.

RUNOFF

This is the runoff into the lake from its drainage area. Regional monthly runoff values were determined from stream gage data.

Monthly runoff volumes in watershed inches was determined at the Little Blue River gage near Lake City. Another gage on Cedar Creek near Pleasant View, Missouri was also analyzed. Results at the lake were nearly the same. Because the soils and topography of Little Blue River is more nearly like that at Adrian, it was selected to represent regional runoff. Some urban area exists in the Little Blue River drainage area, however, the additional monthly runoff volume expected from this area did not seem to effect the result. If runoff did not appear reasonable when compared to rainfall, it was necessary to examine daily rainfall values for that month. Antecedent moisture was estimated for each rainfall event and adjustments to NRCS runoff curve number was made to arrive at runoff for each storm.

EVAP.

Pan evaporation at the Lakeside gaging station near the Lake of the Ozarks was used to determine Pan evaporation. The adjustment to lake evaporation was 0.76.

DEMAND

Adrian water use is shown in file ADRIAN HISTORICAL WATER USE.XLS.
Since 1992 the demand has been fairly constant at 0.373 MGD. The optimized use without pumping from South Grand River is estimated to be only 49,500 gallon per day.

An analysis of stream flow was made for South Grand River at the intake site.

Adrian, Missouri

Water Supply Study

Lower Lake

Storage Volume

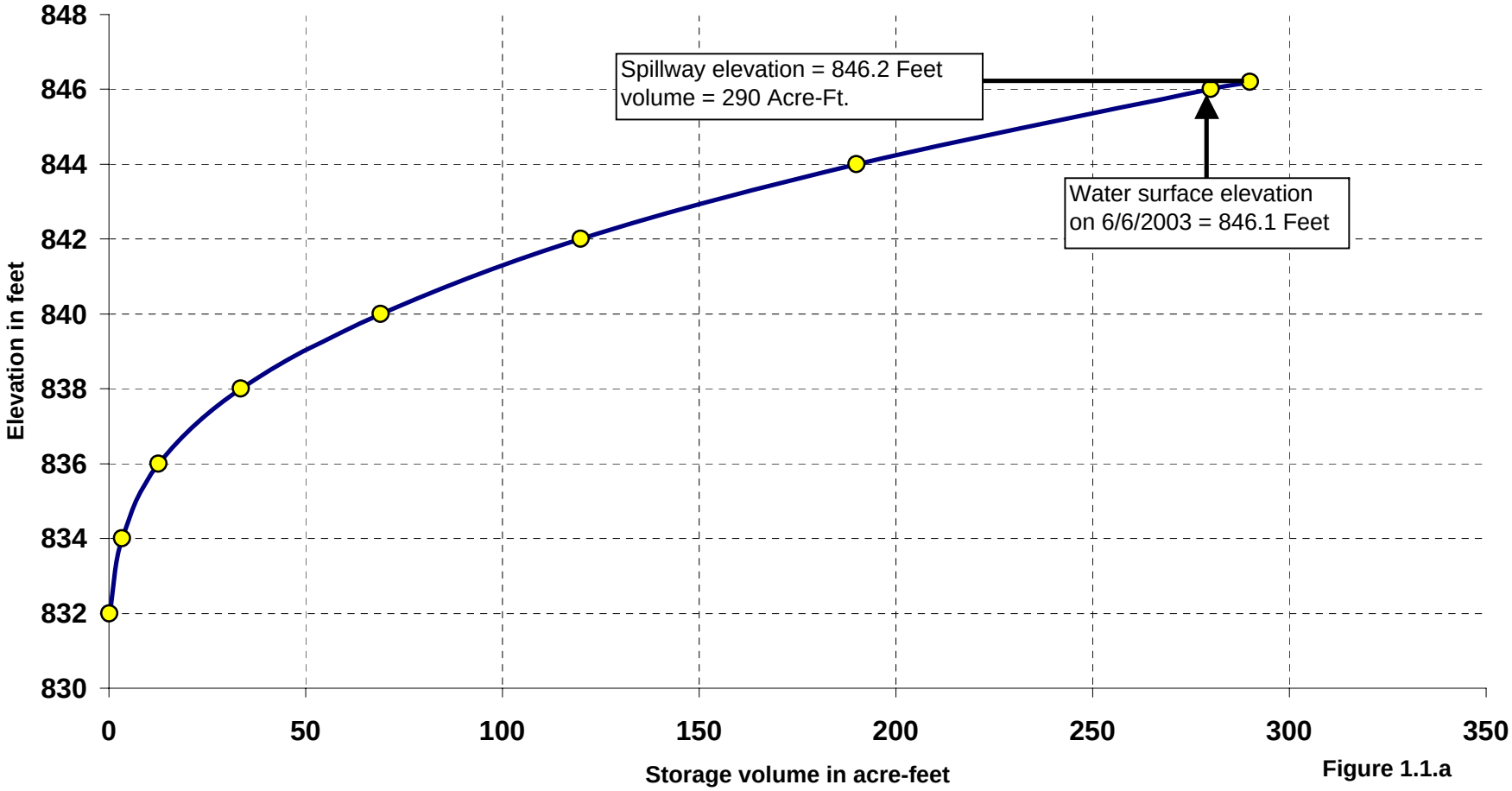


Figure 1.1.a

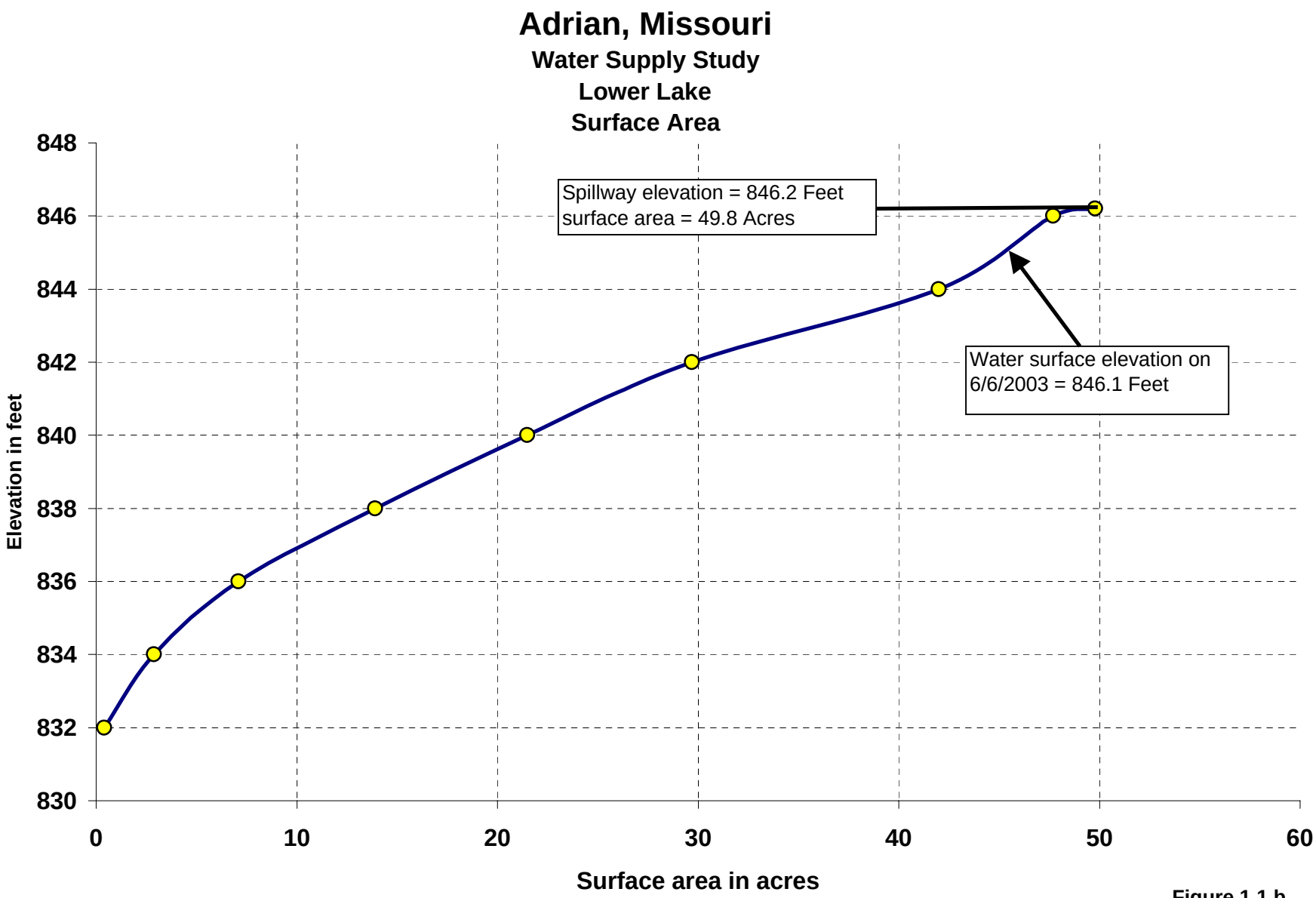

Adrian, Missouri
Water Supply Study
Lower Lake
Surface Area
Spillway elevation = 846.2 Feet
surface area = 49.8 Acres
Water surface elevation on
6/6/2003 = 846.1 Feet
Elevation in feet
848
846
844
842
840
838
836
834
832
830
0
10
20
30
40
50
60
Surface area in acres

Figure 1.1.b

Adrian, Missouri

Water Supply Study

Upper Lake

Storage and Surface Area

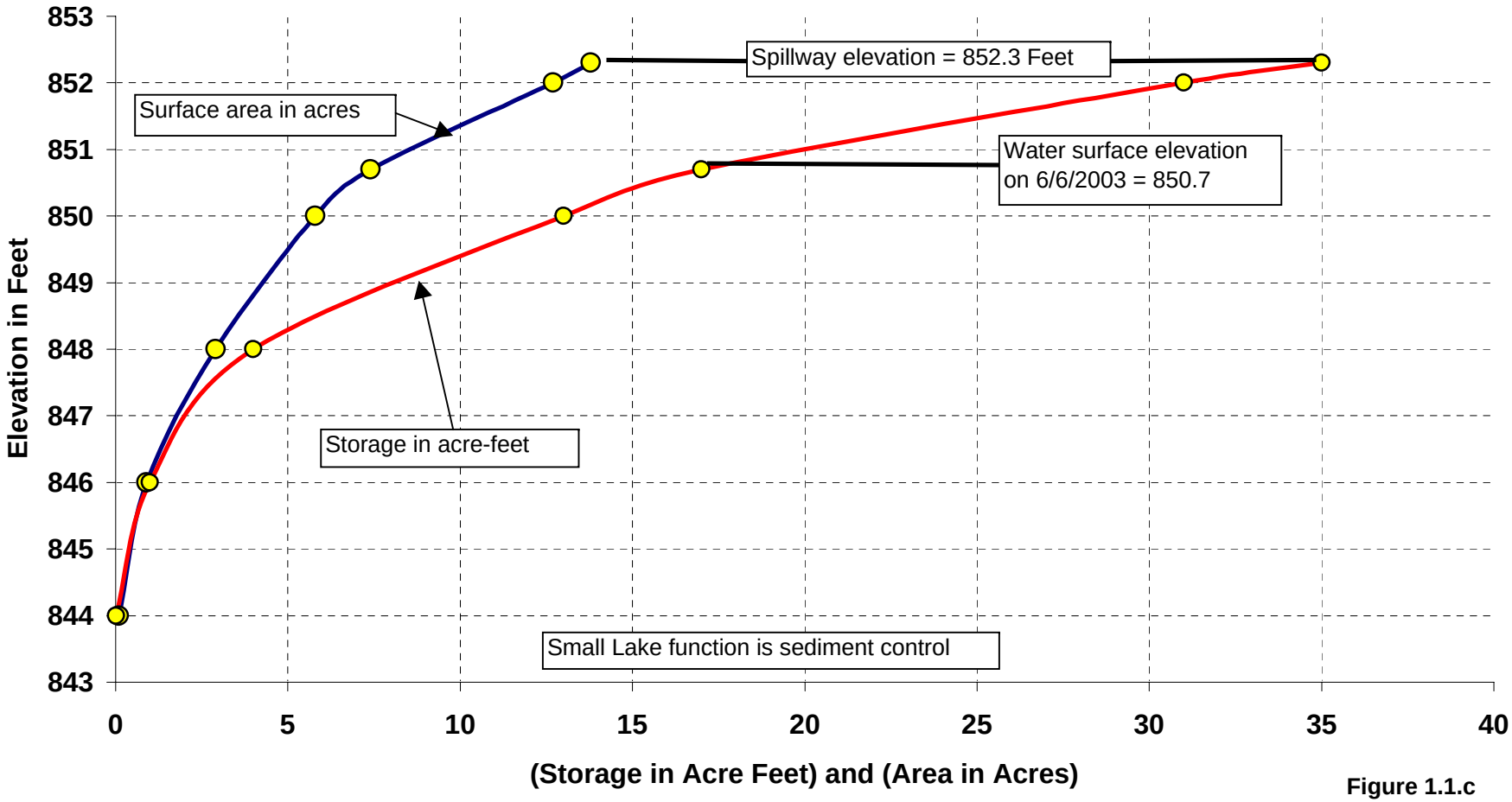


Figure 1.1.c

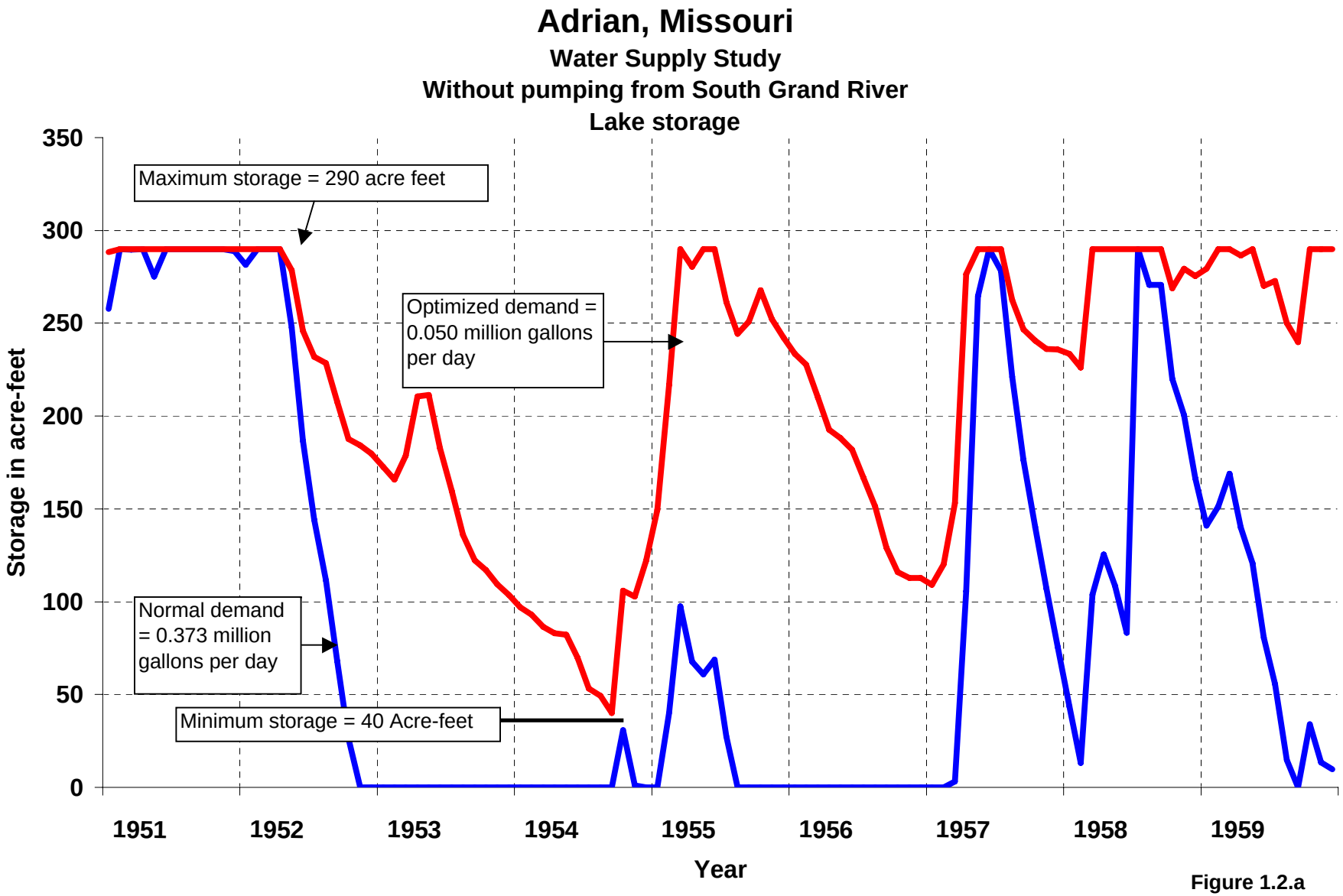

Adrian, Missouri
Water Supply Study
Without pumping from South Grand River
Lake storage
Storage in acre-feet
350
300
250
200
150
100
50
0
Maximum storage = 290 acre feet
Optimized demand = 0.050 million gallons per day
Normal demand = 0.373 million gallons per day
Minimum storage = 40 Acre-feet
1951
1952
1953
1954
1955
1956
1957
1958
1959
Year

Figure 1.2.a

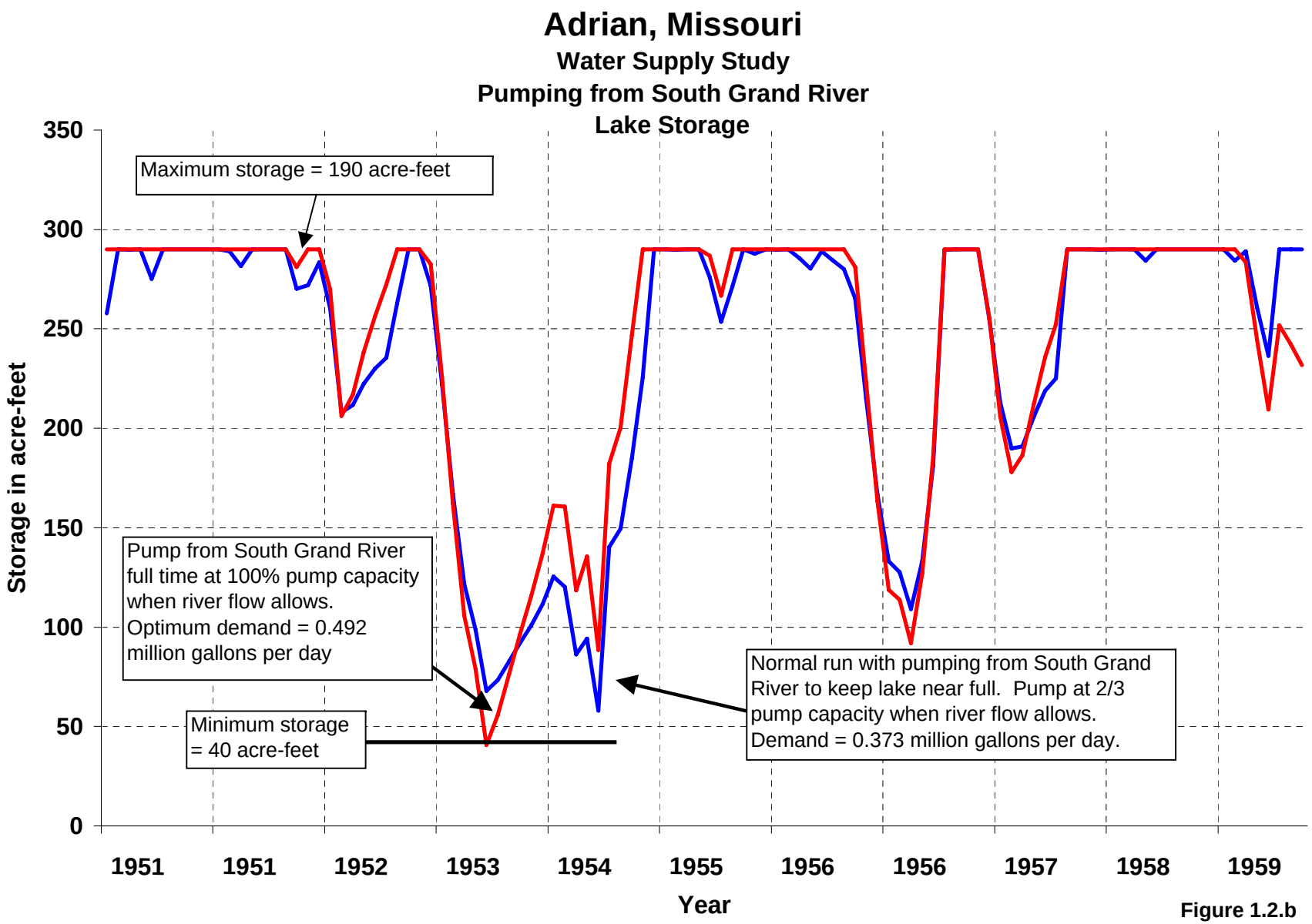

Adrian, Missouri
Water Supply Study
Pumping from South Grand River
Lake Storage
Maximum storage = 190 acre-feet
Pump from South Grand River full time at 100% pump capacity when river flow allows. Optimum demand = 0.492 million gallons per day
Minimum storage = 40 acre-feet
Normal run with pumping from South Grand River to keep lake near full. Pump at 2/3 pump capacity when river flow allows. Demand = 0.373 million gallons per day.
Storage in acre-feet
350
300
250
200
150
100
50
0
1951
1951
1952
1953
1954
1955
1956
1956
1957
1958
1959
Year

Figure 1.2.b

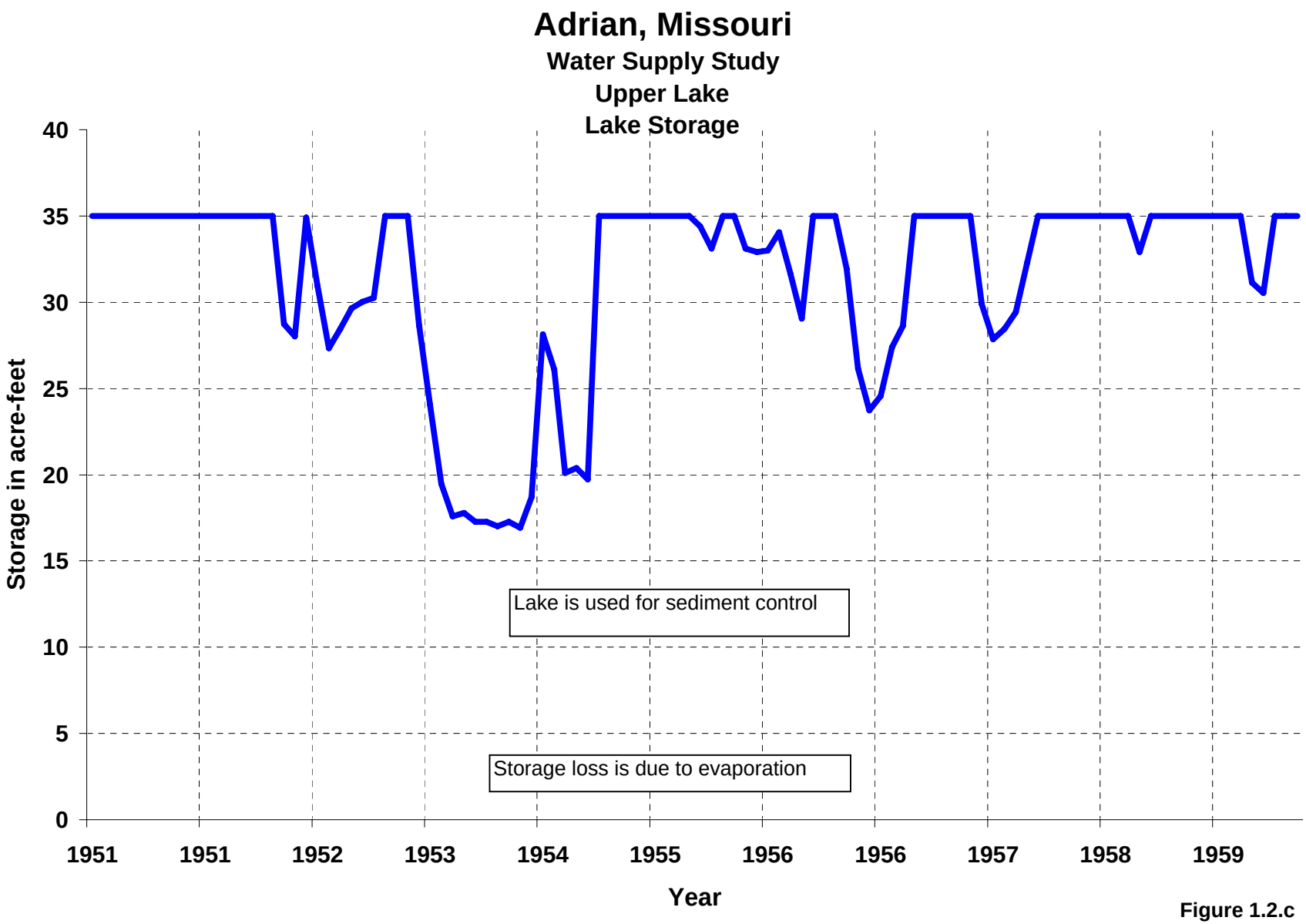

Adrian, Missouri
Water Supply Study
Upper Lake
Lake Storage
Storage in acre-feet
40
35
30
25
20
15
10
5
0
1951
1951
1952
1953
1954
1955
1956
1956
1957
1958
1959
Year
Lake is used for sediment control
Storage loss is due to evaporation

Figure 1.2.c

Adrian, Missouri

Water Supply Study

Water Use

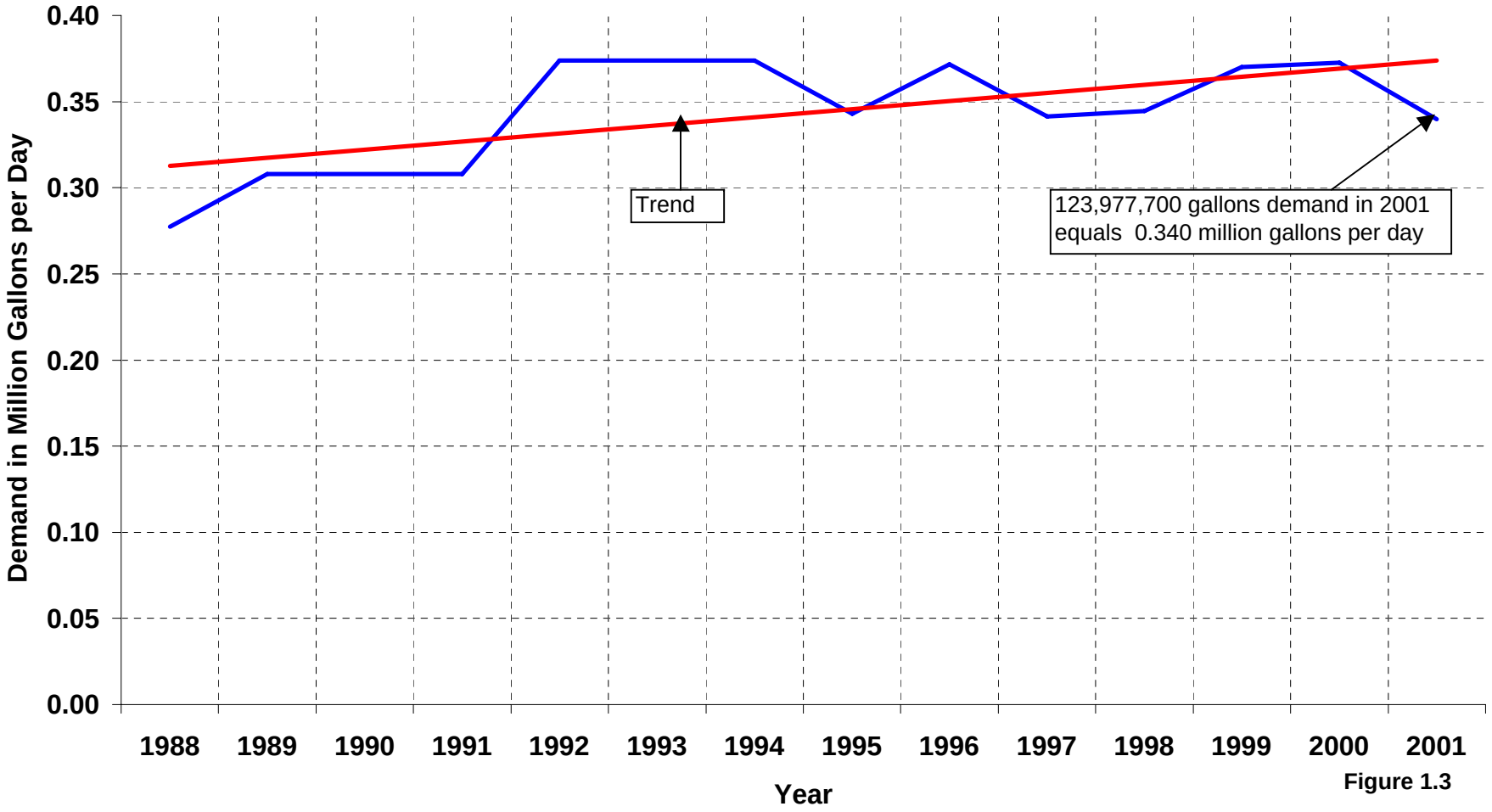
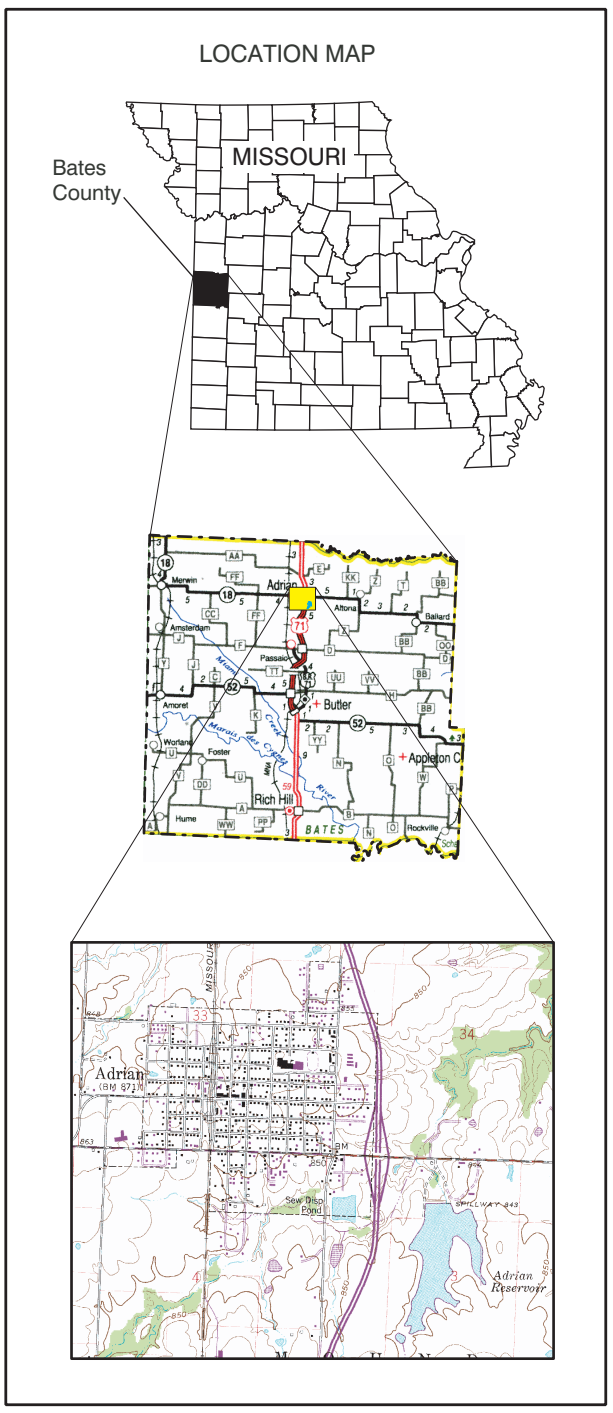
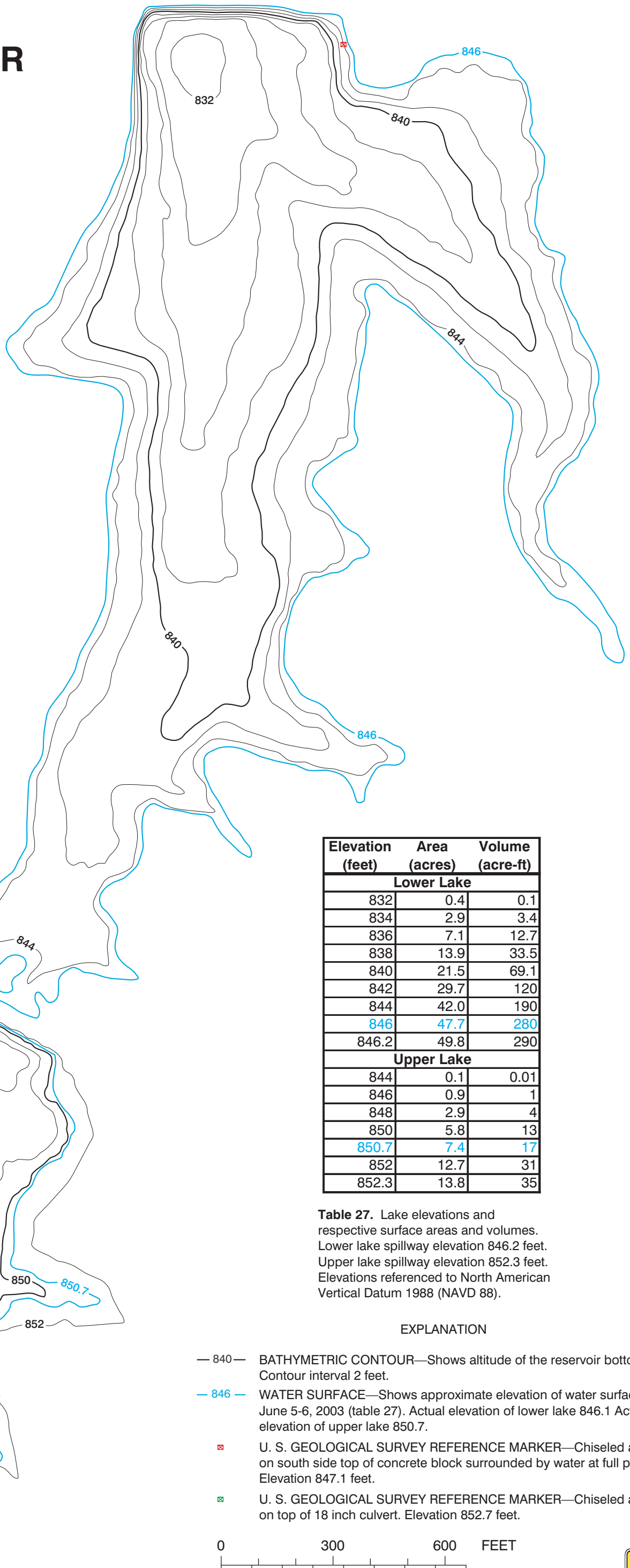


Figure 1.3

ADRIAN RESERVOIR





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842	29.7	120
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846	47.7	280
846.2	49.8	290
Upper Lake		
844	0.1	0.01
846	0.9	1
848	2.9	4
850	5.8	13
850.7	7.4	17
852	12.7	31
852.3	13.8	35

Table 27. Lake elevations and respective surface areas and volumes. Lower lake spillway elevation 846.2 feet. Upper lake spillway elevation 852.3 feet. Elevations referenced to North American Vertical Datum 1988 (NAVD 88).

EXPLANATION

— 840 — BATHYMETRIC CONTOUR—Shows altitude of the reservoir bottom. Contour interval 2 feet.

— 846 — WATER SURFACE—Shows approximate elevation of water surface, June 5-6, 2003 (table 27). Actual elevation of lower lake 846.1 Actual elevation of upper lake 850.7.

U. S. GEOLOGICAL SURVEY REFERENCE MARKER—Chiseled arrow on south side top of concrete block surrounded by water at full pool. Elevation 847.1 feet.

U. S. GEOLOGICAL SURVEY REFERENCE MARKER—Chiseled arrow on top of 18 inch culvert. Elevation 852.7 feet.

0 300 600 FEET

0 100 200 METERS

USGS science for a changing world

Figure 27. Bathymetric map and area/volume table for Adrian Reservoir near Adrian, Missouri.

In cooperation with Missouri Department of Natural Resources